REMARKS

This Amendment is submitted in response to the non-final Office Action mailed December 18, 2003, wherein claims 1 – 13 and 16 were rejected under 35 U.S.C. § 103 as being "obvious" over different combinations of prior art references, and claims 14 and 15 were allowed. In response, claim 1 has been amended, claim 2 has been cancelled, and new claims 21 – 26 have been added. Claims 17 – 20 were previously withdrawn from consideration pursuant to a Restriction Requirement, and have now also been canceled, without prejudice. **Claims 1, 3 – 16 and 21 – 26 are pending.** Reconsideration and reexamination are respectfully requested.

Applicant wishes to thank the examiner for his cooperation in remailing the Office Action, and resetting the response period, as described in the Examiner's Interview Summary concerning the telephone conference between the examiner and the undersigned on November 3, 2003.

RESUBMISSION OF CHAN DECLARATION

Applicant is resubmitting herewith a copy of the previously submitted "Declaration of Albert W. Chan Under 37 C.F.R. § 1.131" ("Chan Declaration"). It appears that the attachment to the Chan Declaration was inadvertently omitted when it was first submitted. With the correction of this defect, applicants submit that they have now effectively "sworn behind" the "Wang" reference.

CLAIM AMENDMENTS AND ADDITIONS

Claim 1 has been amended to more clearly differentiate it over the prior art. Specifically, Claim 1 has added the requirements that at least one of the conducting surfaces has solder on it which is melted when the substrates are joined to make a solder joint. The amendment to claim 1 also incorporates the limitations of former dependent claim 2, which has now been canceled. Amended claim 1 also now specifically requires that the solder joint is formed before the polymer hardens. Support for the amendment is contained in original claim 2, and in the Specification, as filed, for example at page 11, lines 8 *et seq.*

New claim 21 specifies that at least a portion of the step of curing the polymer is performed after the solder joint is formed at a temperature that is lower than the melting point of

the solder. Support for this limitation is found, for example, at page 11, lines 18, *et seq.* of the Specification as originally filed.

New claim 22 specifies temperature ranges for the first and second temperatures of claim 21. Support for these temperature ranges is found at page 11, lines 9 – 20 of the Specification as originally filed.

New claim 23 specifies that the liquid polymeric material is dispensed at multiple points. Support for this limitation is found, for example, at page 7, lines 7 – 16, of the Specification as originally filed.

New claim 24, which is dependent on claim 8, specifies that the polymer fluxing agent retard the curing time of the polymer. Support for this limitation is found, for example, at page 10, lines 20 – 23, of the Specification as originally filed.

New claim 25, specifies that the process is performed in a vacuum. Support for this is found, for example, at page 7, lines 12 – 14, of the Specification as originally filed.

Finally, new claim 26 specifies that the polymer does not contain any metallic or conductive particles. Support for this limitation is found, for example, at page 8, lines 14 – 16, of the Specification as originally filed.

Remarks concerning the patentability of these new claims are set forth below.

REJECTIONS OF THE CLAIMS

Claims 1 – 6 were rejected under §103 as being obvious over Murakami (U.S. Pat. No. 6,133,066) ("Murakami") in view of *either* Chen et al. (U.S. Pat. No. 5,873,161) ("Chen") *or* Higashi et al. (U.S. Pat. No. 5,918,113) ("Higashi"), taken with Kunz (U.S. Pat. No. 4,803,124) ("Kunz"). Applicant respectfully disagrees. Applicant submits that the large number of references used to reject the claims is, in fact, evidence of their non-obviousness. Applicant notes that it is improper to pick and choose isolated features out of context from a variety of very different prior art references and assert, using hindsight gained from the teachings of the present application, that they add up to the claimed invention.

Murakami, the primary reference in all of the rejections, teaches an method for mounting a semiconductor chip on a substrate, where pads formed on the substrate are roughened, a resin is placed on the substrate, a semiconductor device is placed on the resin, and pads on the semiconductor device contact the roughened substrate pads.

(In its prior response, applicant incorrectly described the pads on the semiconductor device as being "solder bumps". In fact the word "solder" does not appear anywhere in the Murakami reference, and the pads on Murakami's semiconductor device are called "bump electrodes.")

As amended, claim 1 of the present application now requires that a solder joint be formed between conductive surfaces by melting solder that is present on one of the conductive surfaces. In contrast, Murakami is directed to a strictly mechanical technique for joining a semiconductor chip to a substrate, which avoids the step of soldering. Thus, Murakami teaches the necessity of roughening a surface prior to connecting the device to the substrate to achieve good mechanical contact. Specifically, the process of forming abrasions of specified depth over a least a portion of the surface is detailed (column 3, line 61 – column 4, line 4). Murakami also teaches that improved mechanical connections are achieved by the combination of the shrinkage of the resin and a mechanical connecting force caused by the contact of abrasions on the substrate pads with the bump connectors (column 5, lines 25 – 40, and column 6, lines 8 – 17). Murakami also teaches the use of very fast setting polymers, that are inconsistent with allowing a solder joint to form before the polymer is hardened. Thus, for example, Murakami teaches using a thermosetting resin that fully hardens in 30 seconds (column 4, line 59).

Applicants note that Murakami teaches an alternative technique to soldering and, therefore, nothing in the reference, either alone or in combination with any of the other prior art of record, suggests using the Murakami technique in conjunction with the soldering step of claim 1 of the present application.

Chen teaches connecting circuit layers by providing raised or projecting "high aspect ratio" "bumps" of solder or other deformable material on conductive surfaces on one of the layers, depositing an adhesive layer over the circuit layer, including over the solder bumps, and contacting the conductive surfaces of the circuit layers, heating and pressing the circuit layers together to permit the projecting bumps to penetrate the adhesive such that the bumps contact the pads on the opposing circuit layer and are deformed to make good contact with the pads, and then hardening the adhesive layer.

Chen teaches the use of solder reflow as a preliminary step, *prior to joining the substrates*, to cause the bumps to increase in height. In this context, and only in this context, does Chen teach the use of a flux. Chen emphasizes the importance of first softening and then

hardening the "adhesive layer" without causing any melting of the "bumps". For example, Chen states:

> "The adhesive is selected to have a lower softening point than that of the metal of the bump 30, and in the case of a thermosetting adhesive, the adhesive flows and/or cures at a temperature less than the melting temperature of the material of the bump 30, *so as to flow and/or cure without melting the metal of the bump 30 or the pads 24, 25*." (Emphasis added, col. 6, lines 60 – 65.)
>
> And,
>
> These heating steps are preferably performed at *temperatures below the melting temperatures of the metal that forms the bump 30*, in order to allow penetration of the bump through the adhesive of the adhesive layer 34 and to avoid excessive out-flow of metal (from melting), that can create short circuits in the resultant structure. (Emphasis added, col. 7, lines 15 – 21.)

Chen suggests that an optional "anneal" step may be used to improve the quality of the circuit connection *after* the adhesive is fully hardened.

Applicants respectfully submit that no suggestion or other motivation has been shown to combine Chen with Murakami. Both references teach significantly different techniques in different contexts. Murakami relies on a mechanical connection which uses essentially rigid pads with rigid "bump connectors", and Chen uses deformable bumps. Murakami is directed to a technique for joining a semiconductor device to a substrate, while Chen is directed to a technique for laminating a plurality of generally flat circuit layers. Chen makes no mention of using the disclosed method with the semiconductor devices, such as those used in Murakami, and the Chen technique, which relies on a strong "clamping" force, appears to be incompatible with such devices. Thus, for example, Chen's Example 2 describes applying a force of 850 psi. There is no reason shown why someone of ordinary skill in the art would be motivated to modify the teachings of Murakami according to the teachings of Chen.

The examiner uses Higashi in combination with Murakami as an alternative to Chen. Applicant respectfully submits that Higashi is entirely different than Murakami and that, again, no suggestion or motivation for combining these references has been shown.

Higashi shows an IC chip mounted on a substrate using a solid, preformed "anisotropic conductive adhesive layer." The anisotropic conductive adhesive layer, which contains an evenly spaced distribution of metallic particles embedded near a surface thereof, is applied to one of the substrates as a solid layer. It is not applied as a liquid layer, as required by the claims

of the present application, and it is necessary to maintain the Higashi adhesive layer as a solid to keep the metal particles embedded in the layer evenly distributed at a surface of the layer. The adhesive layer is then heated to soften it, and projecting metal pads are pressed through the softened layer into contact with the metal particles and the corresponding pads on the opposing substrate.

Higashi describes their invention as making it "possible to eliminate an underfilling step and a curing step in the conventional" process. (Column 5, lines 4 – 6.) Thus, Higashi is an *alternative* to the underfill/curing process of Murakami and, therefore, would not be combined with the teachings of Murakami. Moreover, since neither Murakami nor Higashi teach the use of solder joints in a polymeric layer, the combination of the two, even if such a combination was proper, does not teach claim 1 as amended.

In recognition that the combinations of Murakami and Chen, or Murakami and Higashi do not suggest claim 1, the examiner has also added Kunz to either of these two combinations. Kunz teaches using a nozzle for applying adhesive material in a "starfish" pattern to a substrate to ensure even distribution and spreading of the adhesive material beneath a semiconductor chip. The Kunz invention is used for simply joining an IC chip to a substrate, without regard for connecting opposing conductive surfaces on the two. Specifically, all of Murakami, Chen and Higashi are concerned with making electrical connections between substrates *through* an adhesive layer. On the other hand, Kunz has no such teaching or objective. Thus, Kunz is concerned with attaining even distribution of a flowable liquid adhesive between two flat surfaces. There is nothing in Kunz which suggests that its teachings have application to joining substrates that have projecting contact pads, contact bumps, solder bumps or other irregular features which would affect the flow distribution of material as the substrates are pressed together.

As noted above, Higashi specifically teaches the use of a preformed *uniformly thick* solid adhesive layer, and there is no way to reconcile these contradictory teachings of Higashi and Kunz. Likewise, Chen shows the use of uniformly thick adhesive layer.

In summary, applicant respectfully submits that claim 1, as amended is not obvious in view of any proper combination Murakami, Chen, Higashi or Kunz, or any other art of record.

Regarding claim 3, the examiner asserts, without support, that it would have been obvious to dispense polymeric material on a plurality of dies. The examiner asserts that it was "well-known" and "conventional" for the circuit layers of Chen to have a planar area of at least

about 36 square inches. Applicant respectfully submits that the examiner is required to support this statement. Moreover, even if the examiner is correct, he must show not only that Chen teaches or suggests the use of the claimed large area substrates, but that it would have been obvious to modify Murakami, which is the primary reference, to embrace this teaching. Applicant submits that there is no showing or suggestion to modify the teachings of Murakami to embrace large area substrates. Murakami is solely directed to mounting single chips in "flip-chip" fashion. The fact that Chen is directed to joining circuit layers, rather than chips, is further evidence that the teachings of the two references are significantly different and would not be combined.

Regarding Higashi, which teaches bonding entire wafers comprising multiple dies, it is again noted that the adhesive layer is preformed as a solid film and is applied to the wafer (or other substrate) after it has been solidified into a uniform layer with adhesive surfaces. Thus, Higashi has nothing to do with spreading a liquid polymer. Needless to say, applying an adhesive tape to a surface is much different than applying a uniform polymer in liquid form. Thus, there is no reason use Higashi to extend the teachings of Murakami to cover a much larger area substrate than is taught in Murakami.

As to claims 5 and 6, the examiner again asserts that it is "well known" and "conventional" for electrode bumps to be made of solder and to include a fluxing agent. However, applicant submits that Murakami makes no mention of solder, and repeatedly emphasizes the *mechanical* nature of connection between the "bump electrodes" and the mounting pads. For example, Murakami states that the connection is made by a so-called "anchor effect" which results in "greater mechanical bonding". A very large part of the Murakami patent is directed to describing techniques to abrade the mounting pads to enhance this "anchor effect." In addition, the patent describes using temperatures and pressures that "are low enough so that the structures being joined will not be deformed." Clearly, the teaching of Murakami is against using any type of conventional melted solder joint. Since Murakami does not teach soldering, there is no reason to employ a solder flux. Since Murakami teaches an alternative to soldering, relying instead on mechanical connection, there is no reason to modify it to include a soldering step.

Chen teaches using solder primarily for two reasons: (1) because of the relative ease with which it mechanically deforms; and (2) because it can be made to reflow *in a preliminary* step to make high aspect ratio protrusions that are hardened and subsequently used to penetrate through

the adhesive layer *without melting*. While Chen mentions the use of flux during this preliminary step, both of the examples in Chen state that the "flux was then removed with water" *prior* to the placement of the adhesive layer or the joining of the substrates. (Example 1 at column 10, line 40; and Example 2 at column 11, lines 26 – 27.) Thus, Chen specifically teaches away from the use of a solder flux as part of the process of joining substrates.

Claims 7 – 9 and 16 were rejected as above, with the addition of Wang, U.S. Pat. No. 6,476,676, ("Wang"). It is submitted that this rejection is overcome by the resubmission of the Chan Declaration swearing behind Wang. It is further noted that this rejection rests on the premise that the combinations of other references makes the use of a solder flux obvious. However, as described above in connection with the rejection of claim 6, the combination of Murakami, Chen and Kunz does not make the use of solder flux obvious. Specifically, there is no motivation shown for modifying Murakami to use a solder, and there is nothing in Chen which suggests using a solder flux in joining substrates.

(In the rejection of claims 7 – 9 and 16, the examiner relies in part on Higashi, even though Higashi was not applied against claim 6. Applicant respectfully requests clarification. In any event, Higashi makes no mention of solder or solder flux in joining substrates, and there is no reason to modify Higashi to use a solder for this purpose, nor is there any reason to use Higashi to modify the primary reference, Murakami, to use solder for this purpose. Higashi uses solder balls only as "external terminals" on the opposite side of one of the substrates.)

Claims 10 – 13 were rejected, as above, and further in view of Stephanowski, U.S. Pat. No. 5,334,260, ("Stephanowski"). Again, since these rejections rely on Wang, which has been overcome, they are moot.

Claims 7 – 13 and 16 were rejected as above, except substituting Zhou et al., U.S. Pat. No. 5,985,043, ("Zhou") for Wang. Zhou teaches polymers incorporating fluxing agents for use in flip-chip mounting. Again, this rejection cannot be sustained because it is premised on the erroneous notion that it would have been obvious to modify Murakami and Chen or Murakami and Higashi to use melted solder. As discussed above, there is nothing which suggests modifying Murakami or Chen or Higashi to use melted solder, and Chen specifically teaches away from using flux when joining layers.

PATENTABILITY OF NEW CLAIMS

New claim 21 is dependent on claim 1, and requires that after the conductive joint is formed, the process of curing the polymer layer is conducted at a temperature which is lower than the melting point of the solder. As a practical matter, applicant prefers using polymers which cure relatively slowly in relation to the time required to form a solder joint. This preference is contrary to the teachings of the primary reference which emphasizes the use of epoxies which harden very fast. Murakami's resin are said to cure in 30 seconds. The use of a curing temperature below the melting point of the solder, as specified in claim 21, allows a longer curing time without the risks associated with having the solder maintained in a molten state. It is noted some curing occurs during the higher temperature process of forming the solder joint, and so only a portion of the curing process occurs at the lower temperature.

New claim 22, which is dependent on claim 21, specifies the temperature ranges for the soldering operation and for the subsequent curing operation.

New claim 23, which is dependent on claim 1, specifies dispensing the polymer at multiple locations on one of the substrates. The specification of the present application points out that this is useful when joining large substrates. Nothing of this nature is shown in the primary reference, Murakami, or in the secondary references, Chen or Higashi. The tertiary reference, Kunz, shows the use of dispensing polymer at multiple locations in its description of the prior art, but goes on to emphasize that this prior art practice causes uneven layers and, therefore, is problematic. Thus, given the teachings of the prior art, there would be no reason to use the discredited, problematic method of the prior art described in Kunz with the techniques shown in any of the other references.

New claim 24, which is dependent on claim 8, specifies the use of a polymer fluxing agent that retards the curing of the polymer. This is useful as it facilitates formation of the solder joint prior to the time the polymer hardens. This is not discussed in the prior art of record.

New claim 25, which is dependent on claim 1, specifies that the process is performed in a vacuum. This is useful when dispensing polymer at multiple locations on large area substrates, to avoid entrapment of air bubbles. This is not discussed in the prior art of record.

Finally, new claim 26, which is dependent on claim 1, clearly distinguishes over Higashi, which discloses the use of conductive particles in the polymer.

CONCLUSION

In view of the amendments and remarks made above, applicants respectfully submit that the application is in condition for allowance and action to that end is respectfully solicited. If the Examiner should feel that a telephone interview would be productive in resolving issues in the case, he is invited to telephone the undersigned at the number listed below.

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